Sensing for Yield – Pest/Pathogen Management

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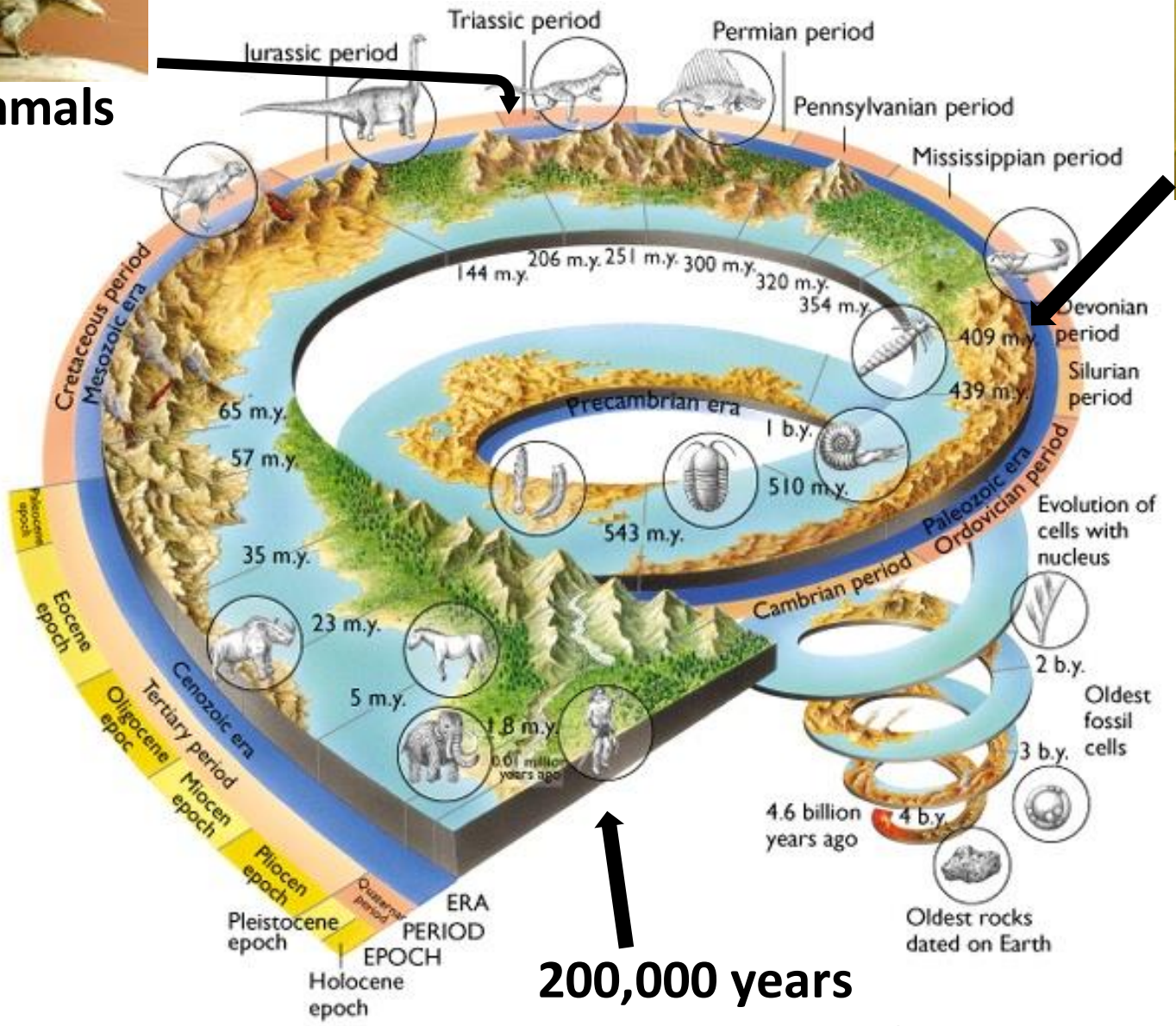
Image: garden365.com

WHY SO MANY PESTS?

- Small
- Reproduce quickly

First Mammals

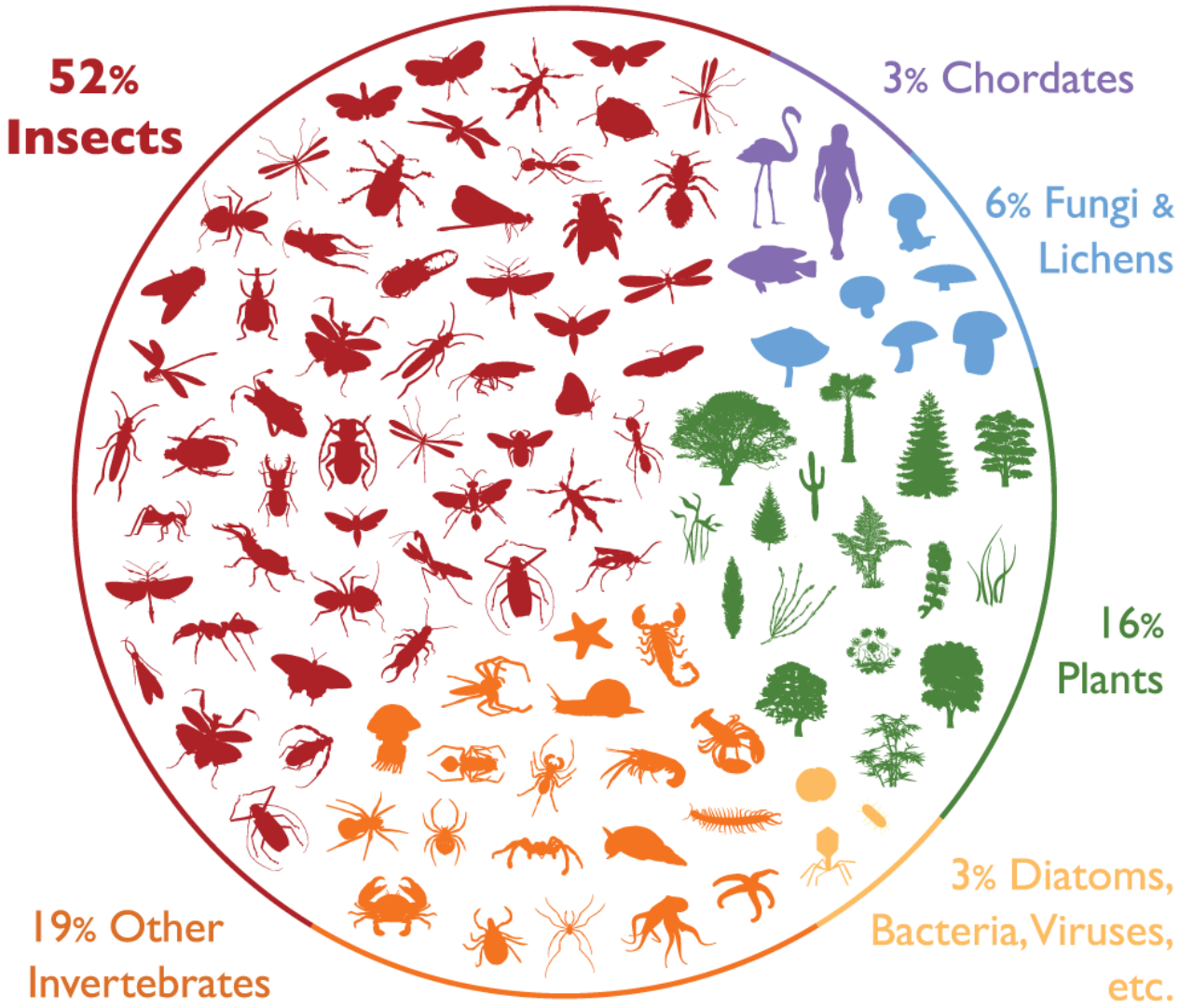
First Insects



200,000 years

= Modern people

Insects represent more than half of Earth's described diversity



Data: Chapman 2009, Image: Cara Gibson

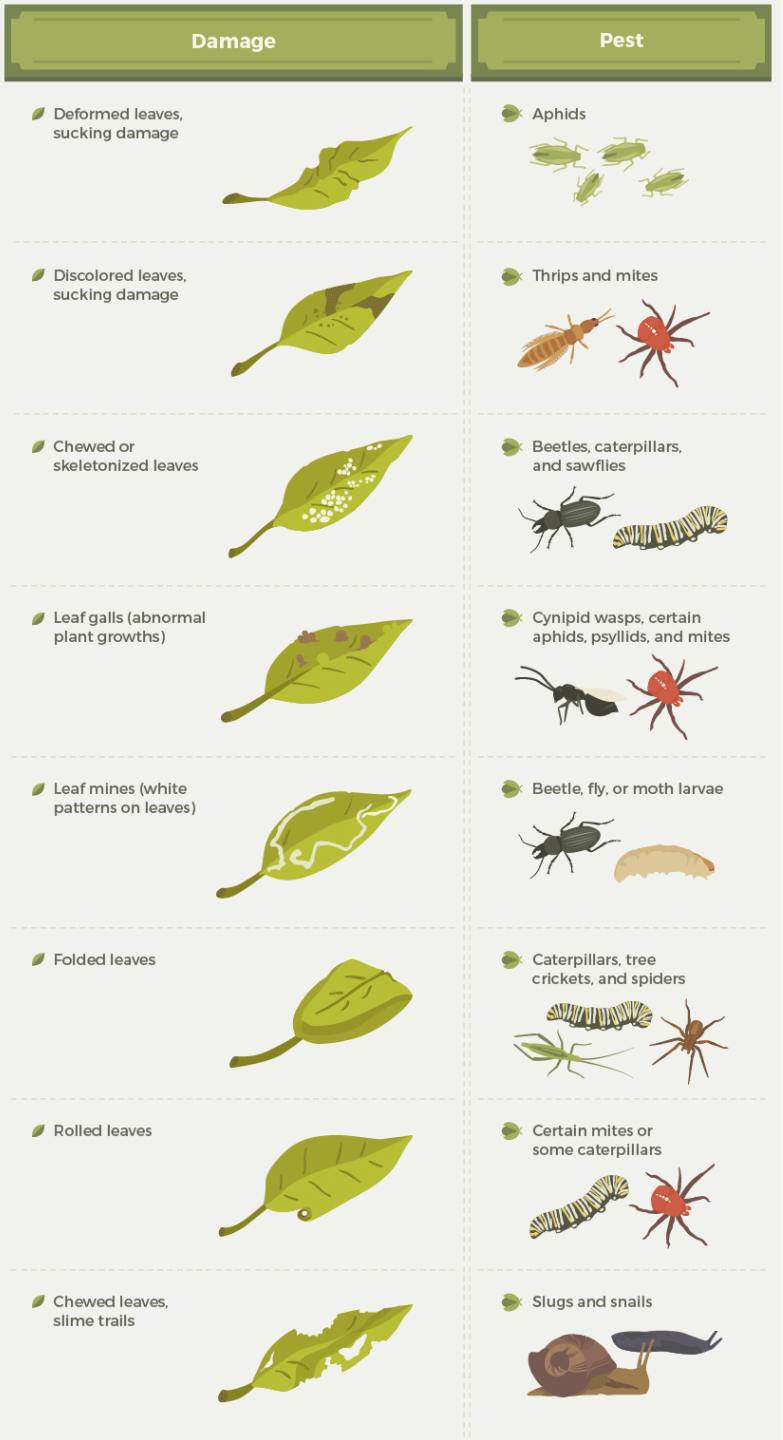


Image: commonsenseevaluation.com

- Different organisms can cause similar types of damage
- But may require different control methods
- Detailed understanding of the biology of each system is required

(Note: soil dwelling, seed- and root-feeding damage types not shown)

Integrated Pest Management (IPM)

UN defn:

"The careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment.

IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms."

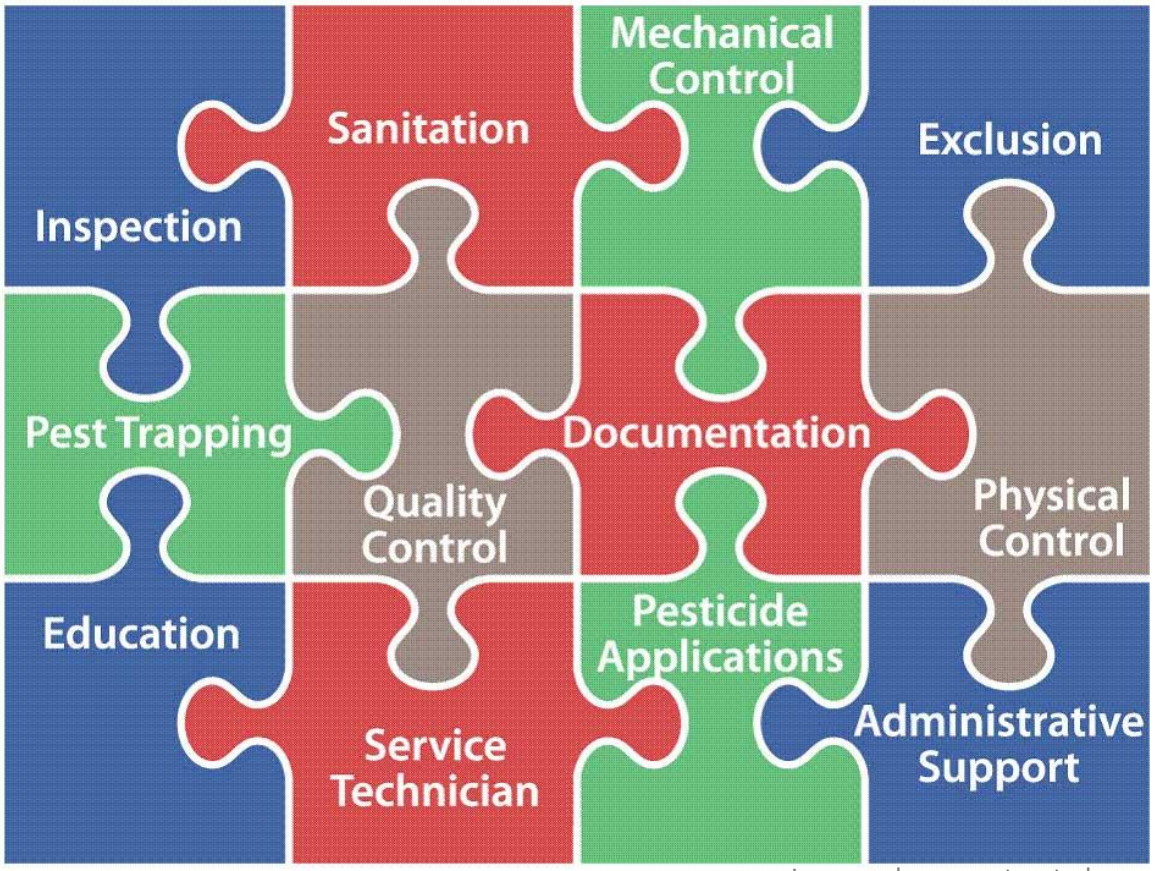
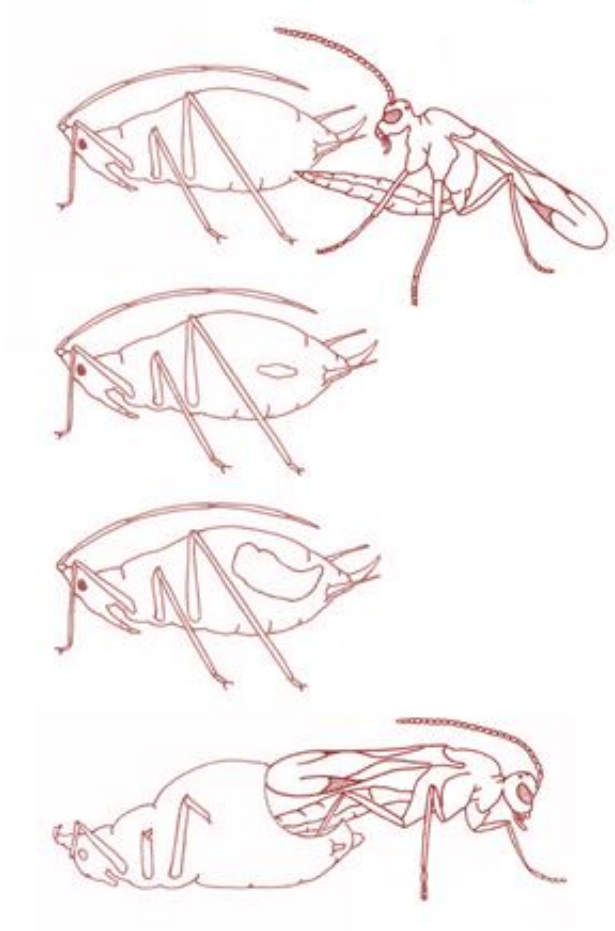


Image: advancepestcontrol.com

Features of IPM

- presence of pest ≠ problem
- “manage” rather than “control” or “eradicate”
- decision-making process before disruptive controls
- farm (or plants) as part of agroecosystem
- compatibility of multiple tactics for control, includes consideration of multiple pests simultaneously
- combination of methods to supplement natural controls
- detailed knowledge & consideration of ecological relationships



Preserving natural enemies/beneficial species is key.

Image: Cara Gibson

"Integrated control is most successful when sound **economic thresholds** have been established, rapid **sampling methods** have been devised, and selective insecticides are available."

Stern, Smith, van den Bosch & Hagen 1959, Hilgardia

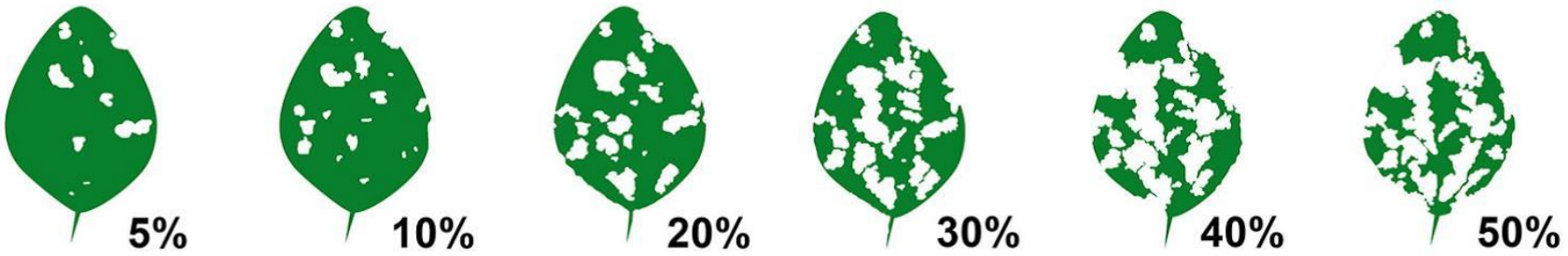
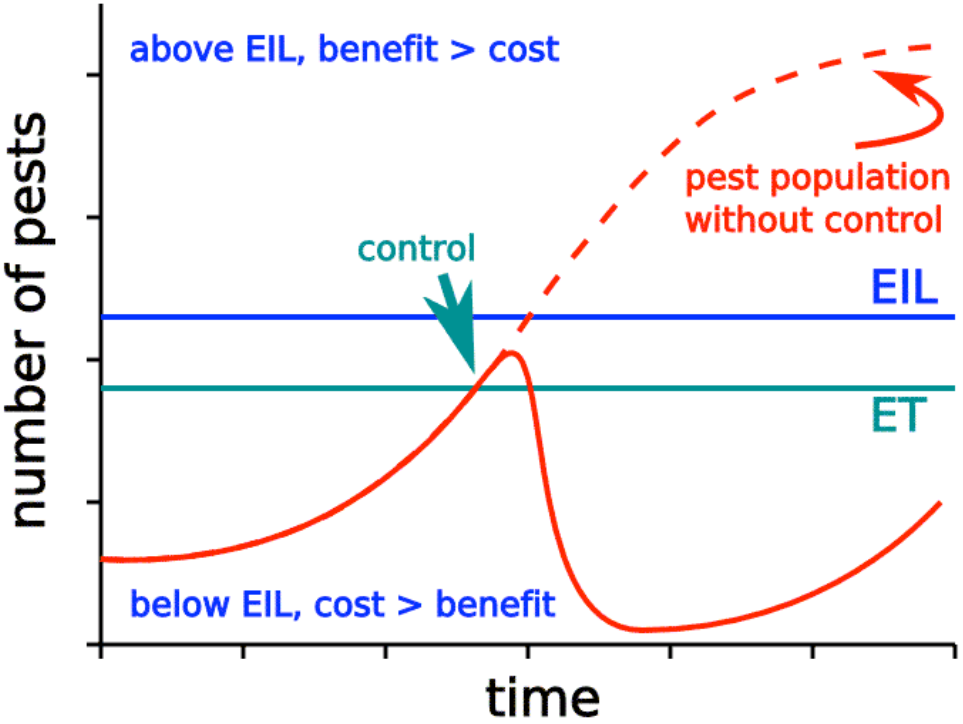


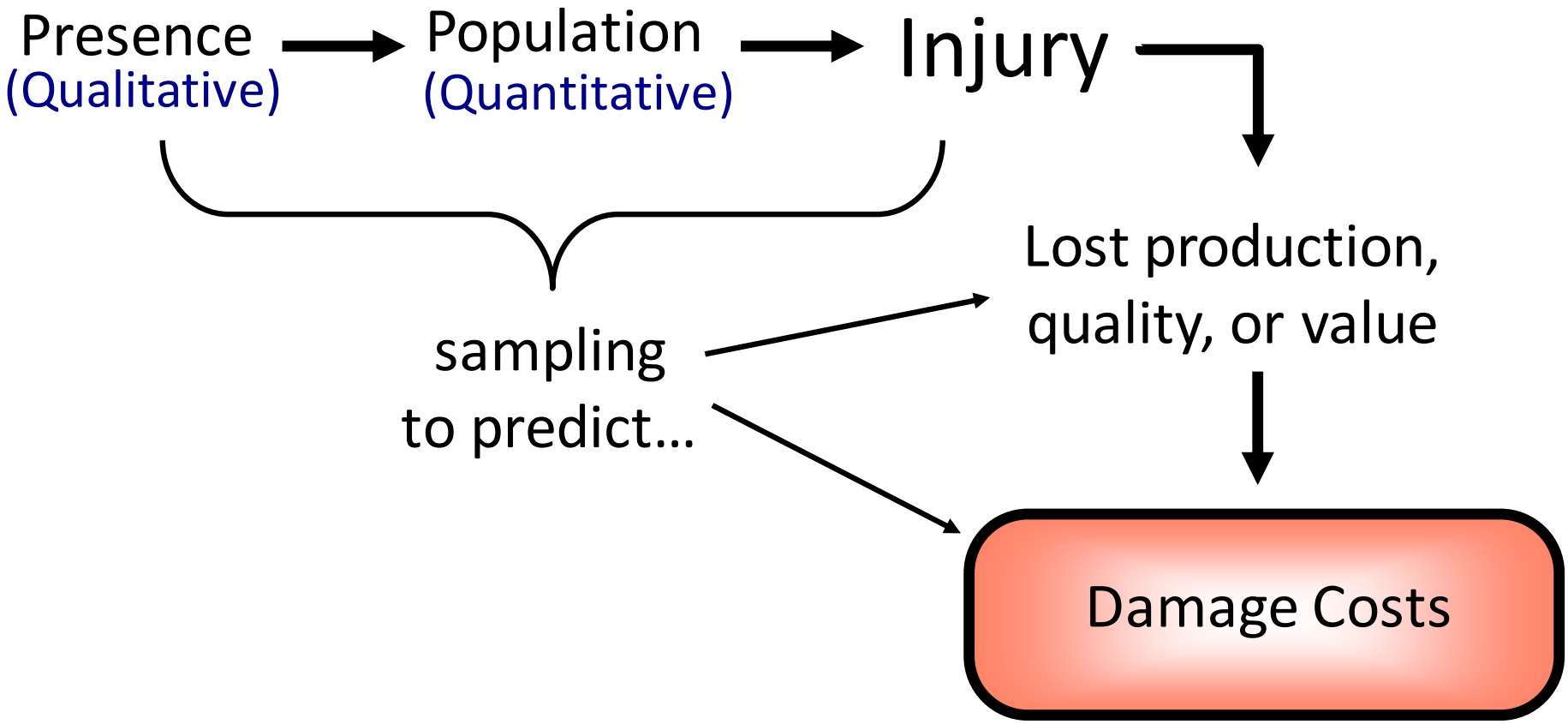
Image: Novusag.com

Thresholds



- Economic Injury Level (EIL) = point at which economic losses will occur if pest not controlled
- Economic threshold (ET) = pest density at which control should occur to prevent the pest from passing the EIL.

Assessing the threat - Sampling



Sampling Characteristics

- Common sampling unit (e.g. leaves, or minutes)
- Unit chosen must be carefully defined and consistent with feeding habits of pest
- Number of samples taken must be adequate; determined on a case-by-case basis, and by time and equipment constraints
- Standardized methods among instruments/individuals

Scale insects on stems

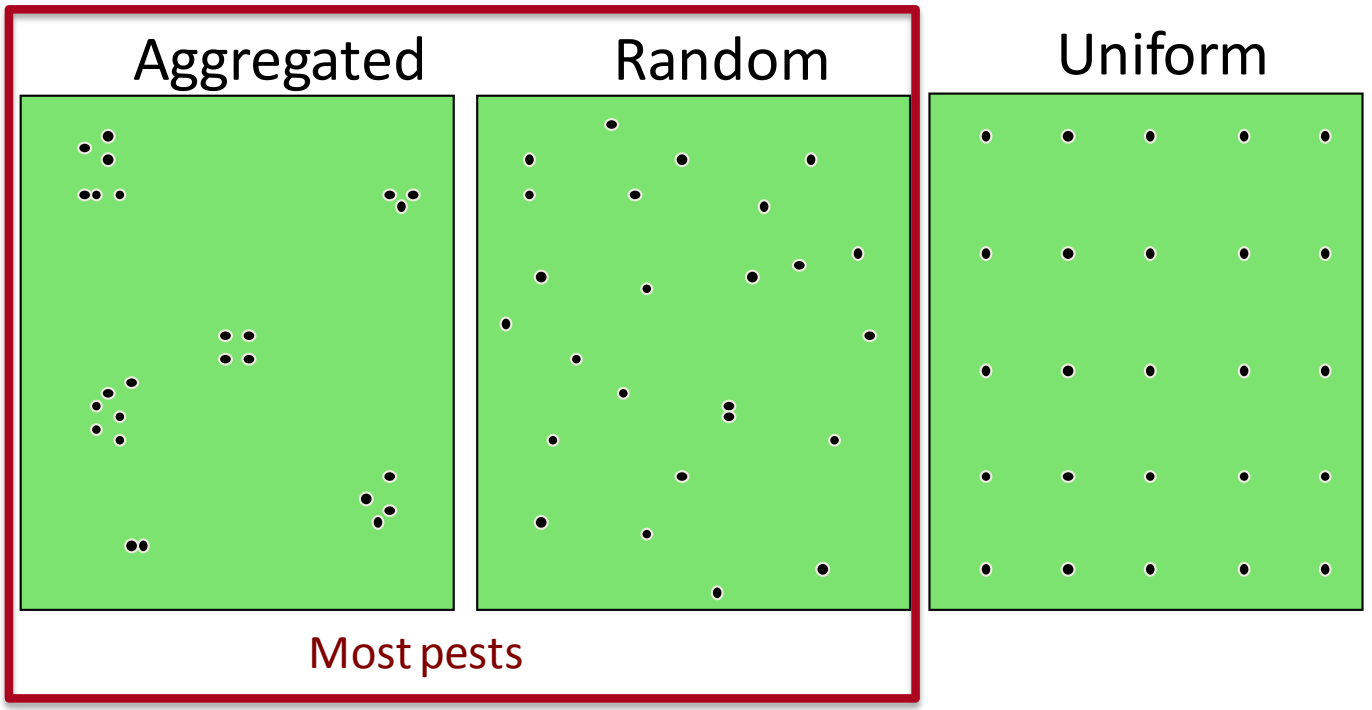
Image: M. Marlow

A different scale species on leaves

Image: McKinley Arborists

Sampling Characteristics

Pests are seldom distributed uniformly in a field.



Similarly, every plant will not be infested to the same degree.

Absolute vs. Relative Samples

Absolute methods - estimate density from precise area; used to compare densities based on area (e.g. Visual examination, Emergence, Aerial nets)

Relative methods - estimate density without strict regard to area sampled; used to compare among efforts (e.g. Timed counts, Traps: Visual, Chemical, Interception)

Population indices - measure products or effects of a population (e.g. Excrement, Emergence holes, Sounds)

Frass (= excrement) and holes from furniture beetles

Honeydew (= excrement) from aphids

Sampling Methods

- Triggers - rely on events that have a direct relationship to pest development, e.g. after seeing adults mating, monitor for eggs

- Specialized tools, e.g. pheromone traps

Image: Evergreen Growers

Sampling Methods

- Injury scales - scout can readily compare sample with known levels of infestation. Often used to get rapid estimate of the extent of infestation

Adults (% infested)		Nymphs (% infested)
0 – 25	Don't Spray	0 – 25
25 – 40	See Matrix	25 – 40
40 – 60	Stage I	40
60 – 75	Gray Area	
75 – 90	Adulticide	
90 – 100	Yield Loss	80 – 100

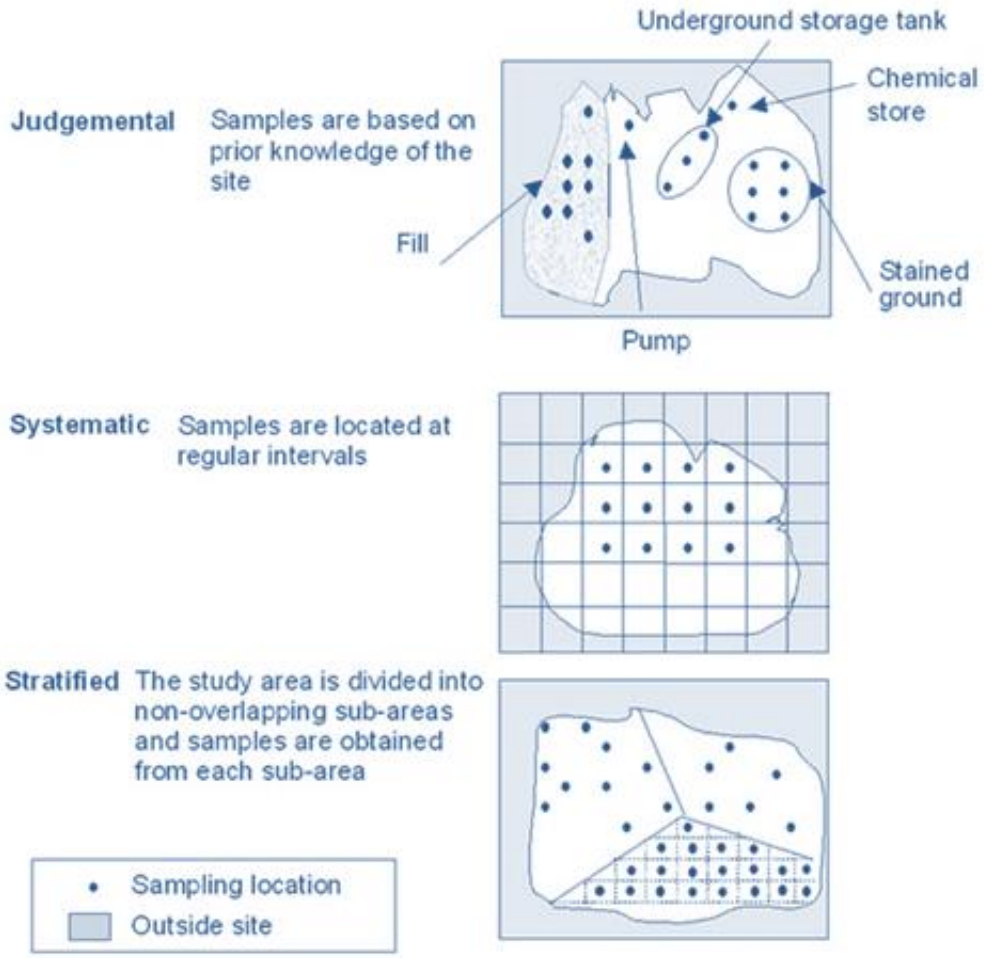
Sampling Methods

- Sequential sampling - efficiently concentrates efforts where most beneficial; requires fewer samples to arrive at a decision with same degree of certainty as standard sampling

- Multiple species sampling – counting multiple pests and natural enemy species can increase sampling efficiency when species are present at same times

Image: Stephen Ausmus, USDA-ARS

Sampling Patterns



- Systematic sampling ensures relatively even spatial distribution of samples across the site
- Generally easier to implement in the field.

Meteorological Sampling Considerations

- Insects are cold-blooded and sensitive to temperature; typically responding to higher temp.s with increased rates of development, & less time between generations.

- Species can have distinct responses to weather (E.g., decreases in barometric pressure causes some to reserve eggs, and others, faced with certain mortality, to “egg dump”)

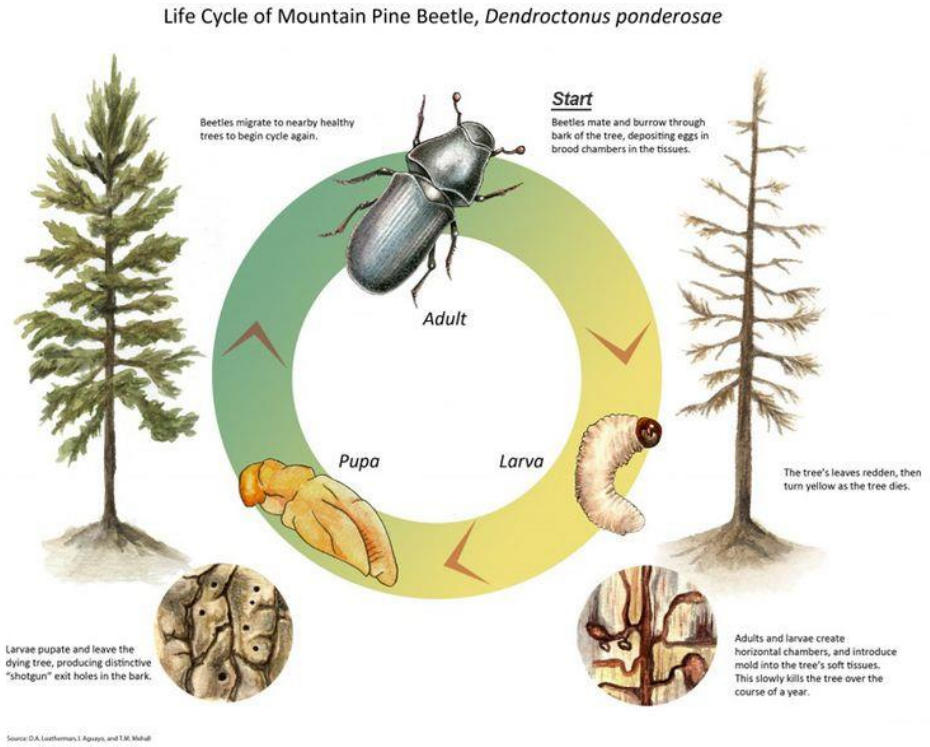
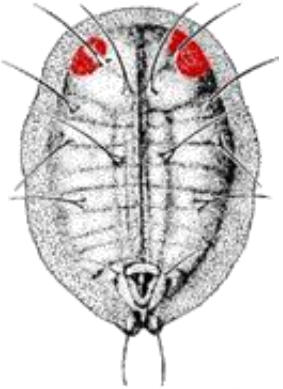


Image: Sean Twiddy

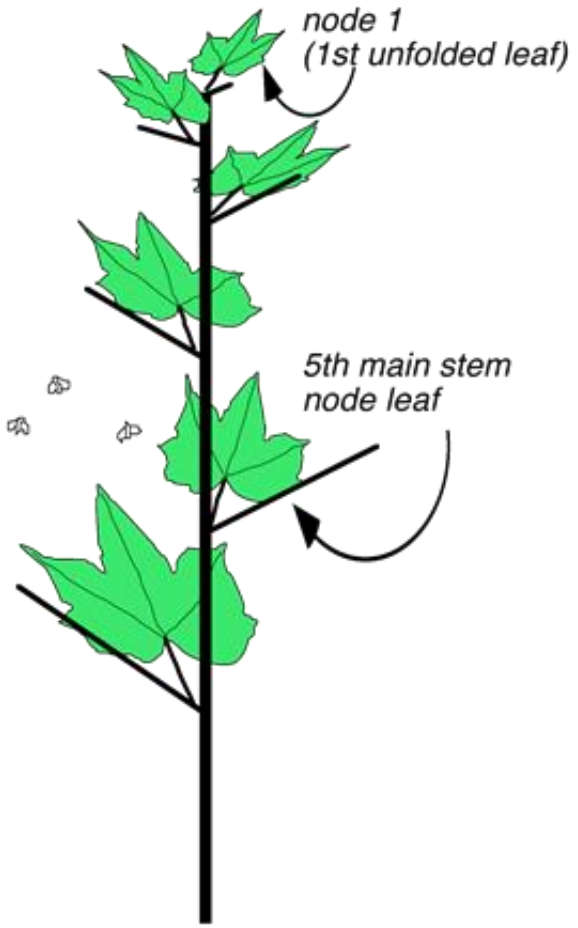
Case Study: Sampling Whiteflies in Cotton



Peter Ellsworth, IPM specialist, MAC

Sampling in Cotton

- Survey crop growth stage
  - Identify general location of fifth leaf
- Approach & select plants at random
  - Keep shadow off of plant
  - Turn leaf by tip or stem
- Stem should snap off easily
  - Use 8x lens with disk template
- 30-leaf & 30 leaf disk sample
  - Inspect 15 leaves in two locations (found to be adequate for the vast majority of management decisions)
- Concentrate on at-risk fields, locations, scenarios

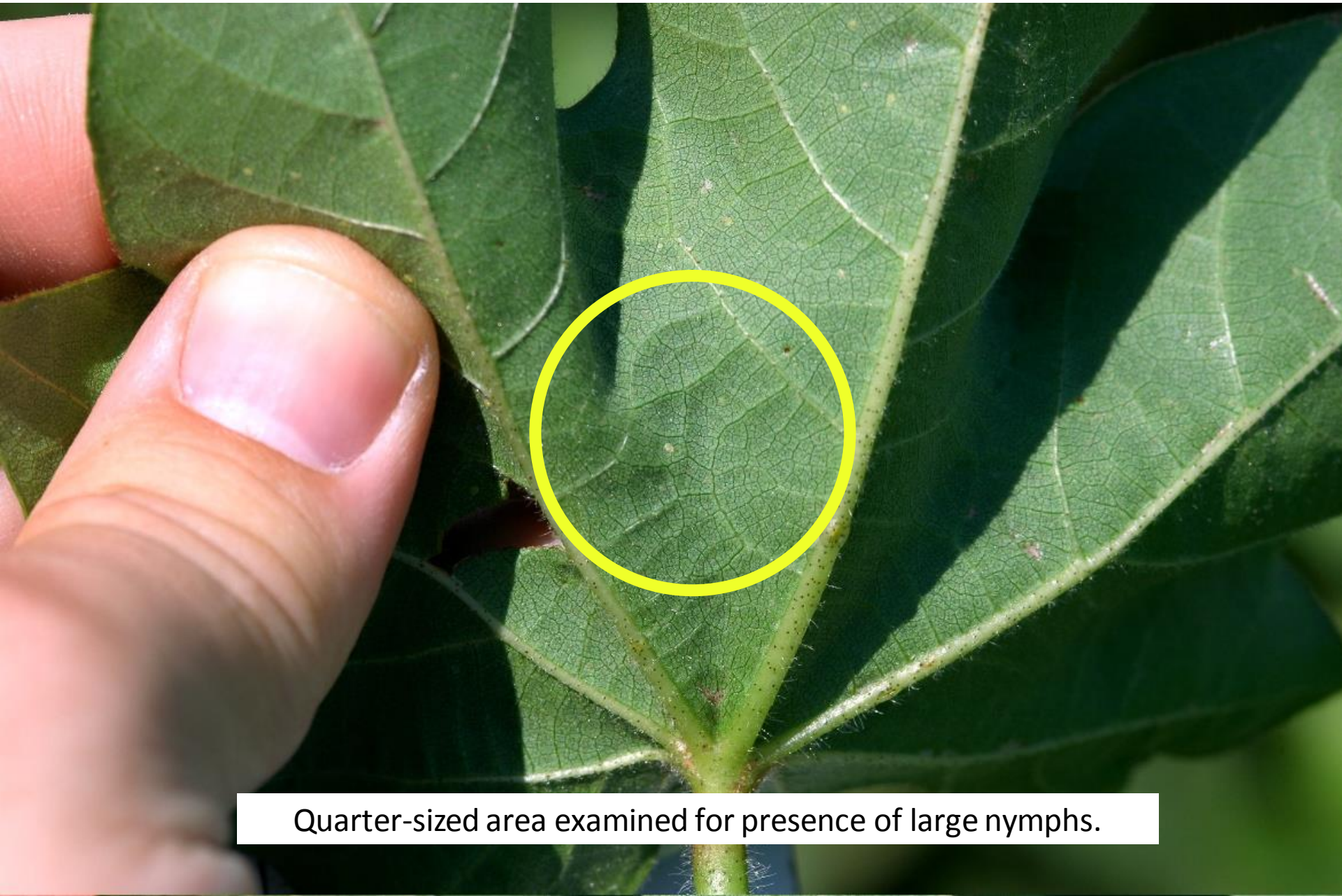


This type of specificity may be necessary for users to efficiently adopt and implement.

Quick Leaf Turn

3 or more adults = infested

Check 5th leaf between mid & lateral vein



Quarter-sized area examined for presence of large nymphs.


≥ 1 large nymph = infested

Additional Context Also Vital

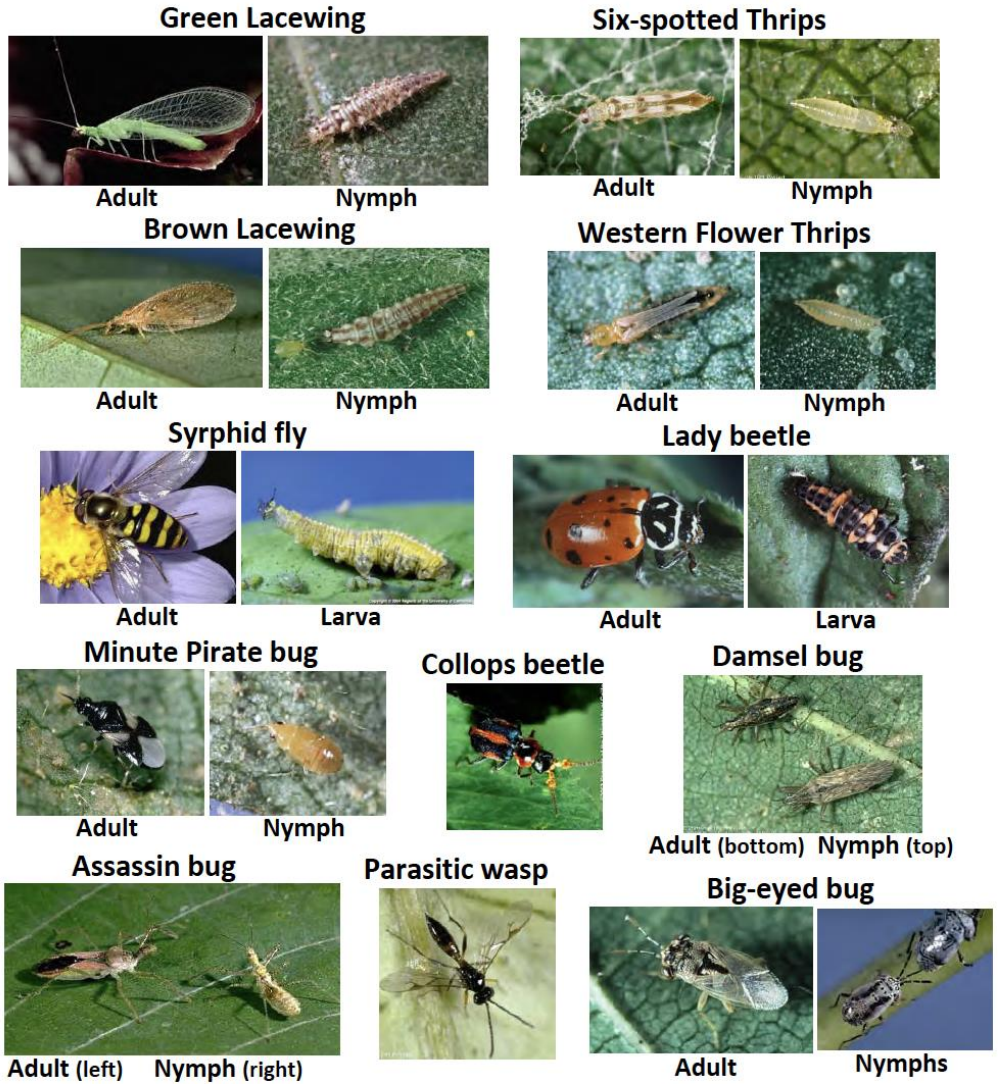


Image: UCIPM

- Crop growth stage
  - Faster growth early-season
  - Slower growth late-season
- Adults
  - measure pressure on field
- Nymphs
  - measure in-field production
- Monsoon
  - Rain can disrupt adult counts for 24 hrs
  - Dust & wind can reduce numbers significantly
- Natural enemies
  - Can have a dramatic impact on pest numbers
- Presence of other pests
  - Must use chemicals that will not disrupt natural enemies/beneficial control of additional pests

Limitations of thresholds & predictive tools

- EILs are difficult & expensive to experimentally derive.
  - provisional ETs that are research-based and depend on some understanding of pest/damage dynamics are commonplace, **but often are not dynamic** (i.e., they do not change through a season or even with constantly changing market conditions).

- Sometimes research does not support even the establishment of provisional thresholds.
  - Practitioners then depend on field experience and implement nominal thresholds.

- Predictive tools are often limited because they are based on models that make inappropriate assumptions about how pests respond to temperature

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